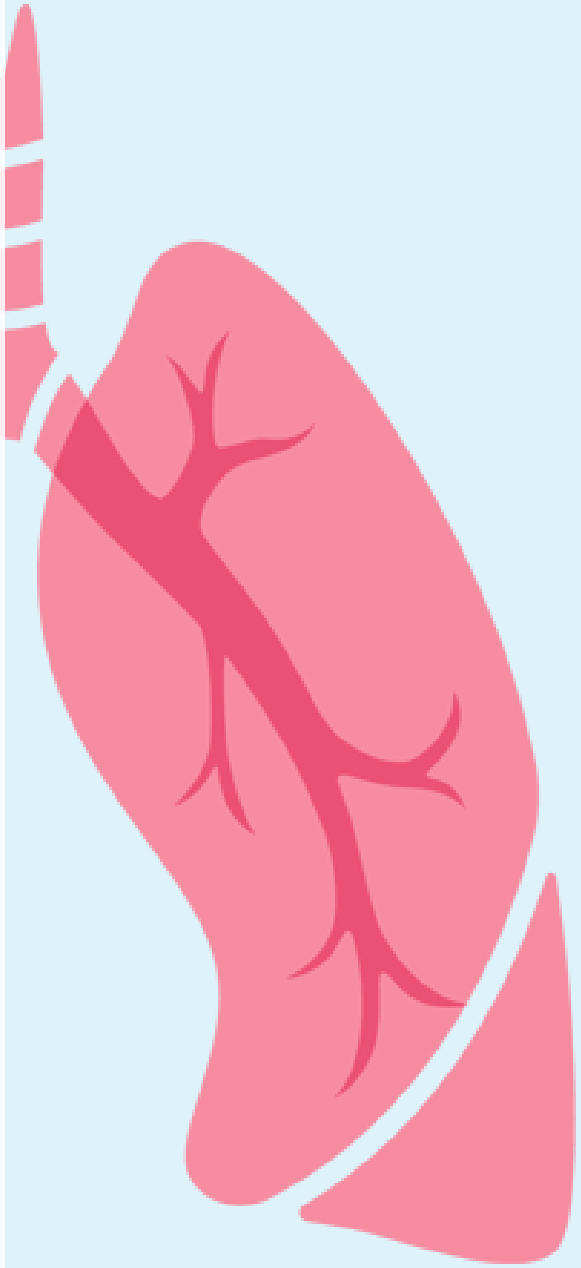
Cambridge Assessment International Education

AS Level
Chapter 9

Gas Exchange



Chapter Outline

Structure and function of….

- Lungs
- Trachea
- Bronchi
- Bronchioles
- Alveoli

…and its components:

- Ciliated epithelium
- Goblet cells
- Mucous glands
- Cartilage
- Smooth muscles
- Elastic fibres
- Squamous epithelium

**** You must be able to identify it in micrographs and draw plan diagrams***

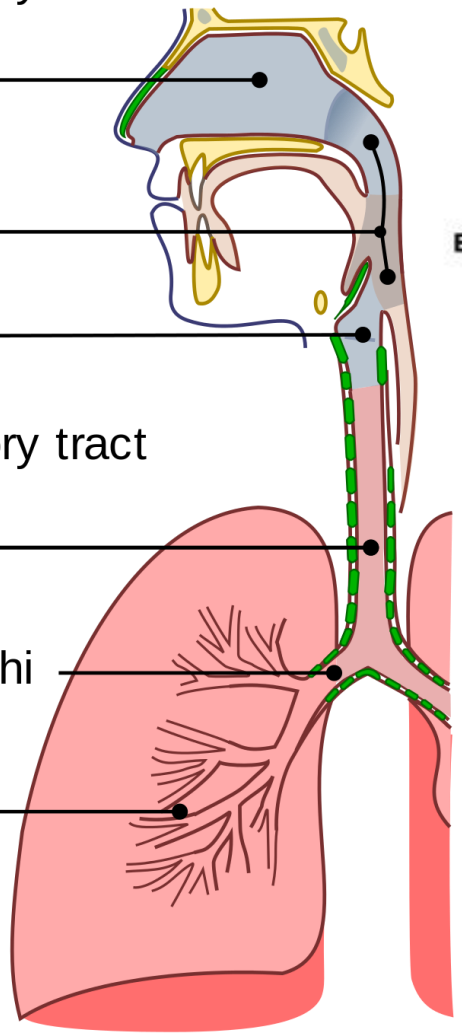
Trachea → Bronchi (singular: bronchus) → Bronchioles → Alveoli (singular: alveolus)

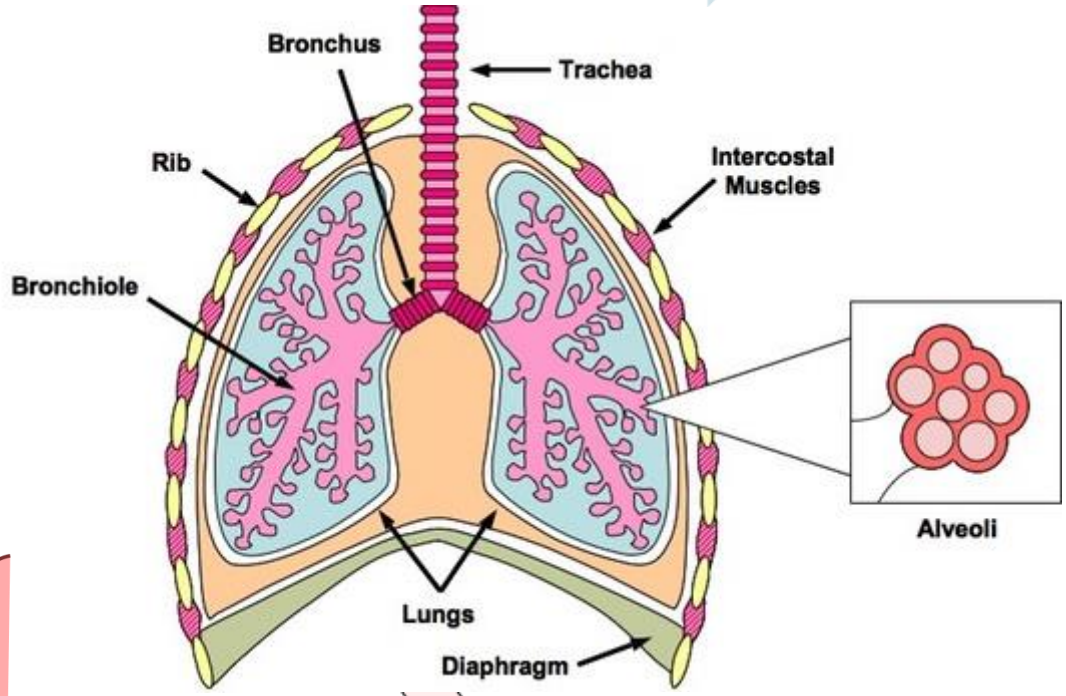
Upper respiratory tract

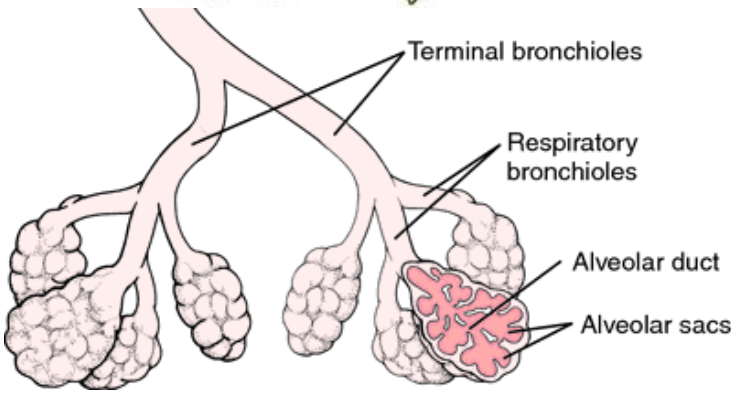
- Nasal cavity
- Pharynx
- Larynx

Lower respiratory tract

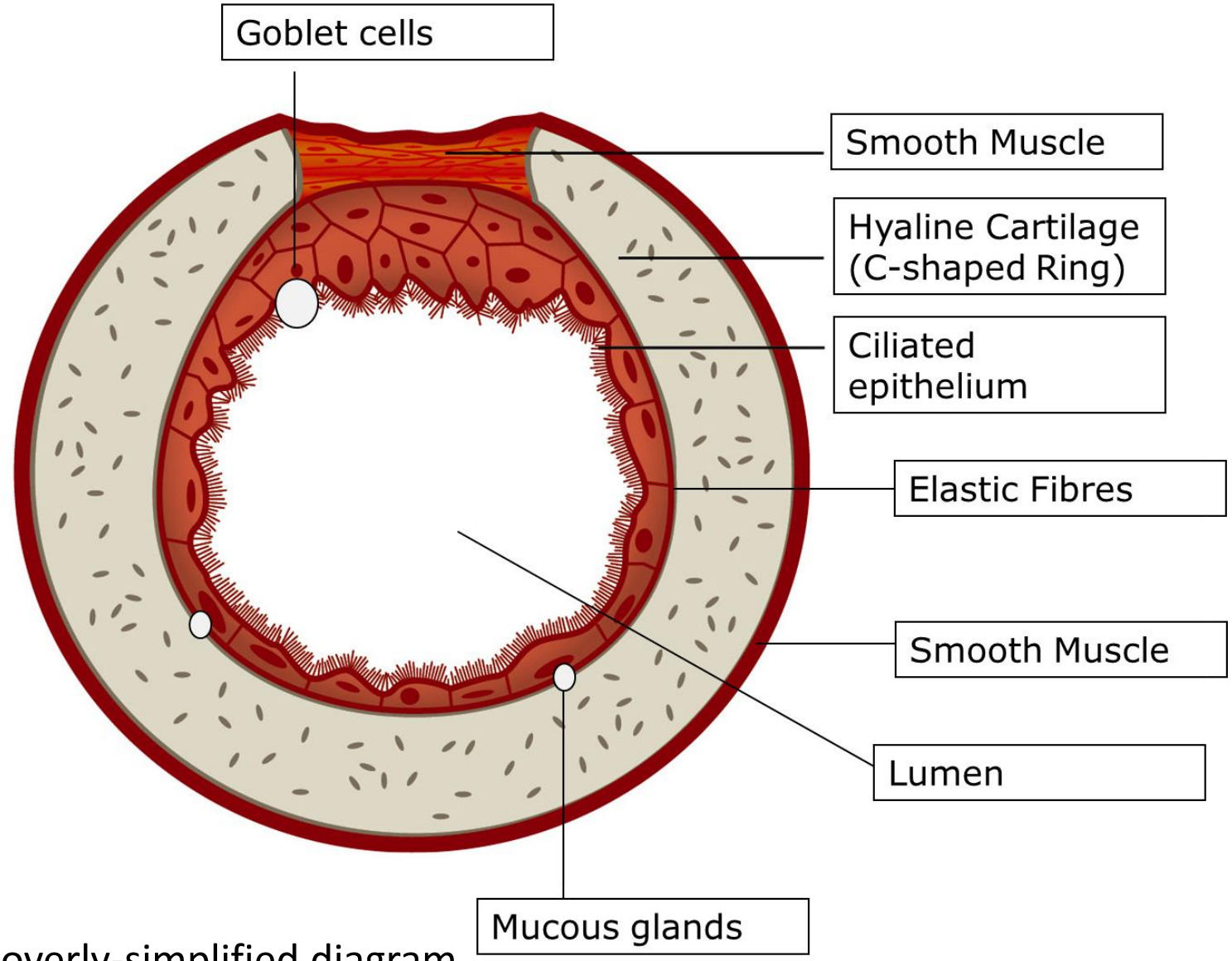
- Trachea
- Primary bronchi
- Lungs





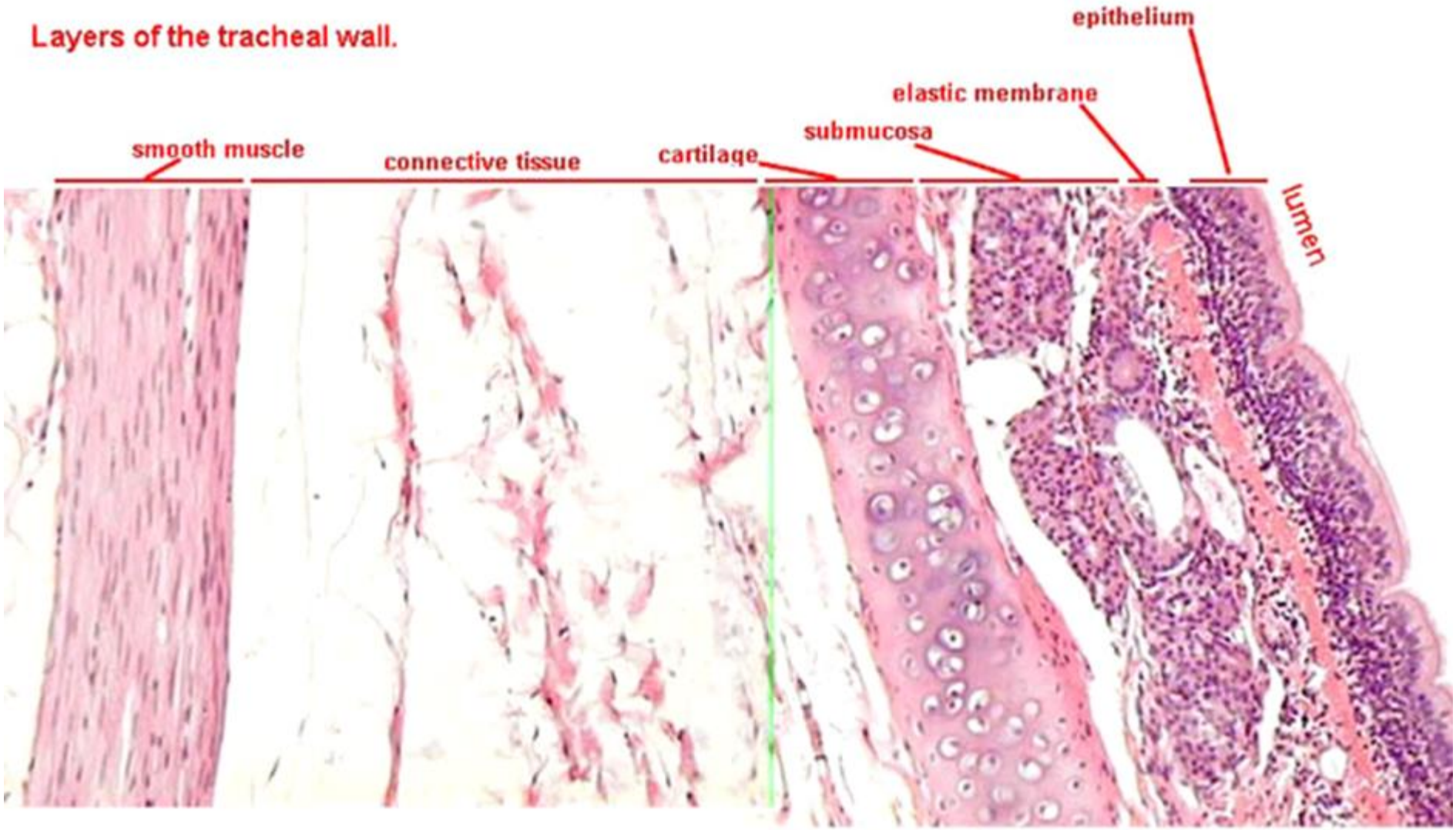


1. Trachea

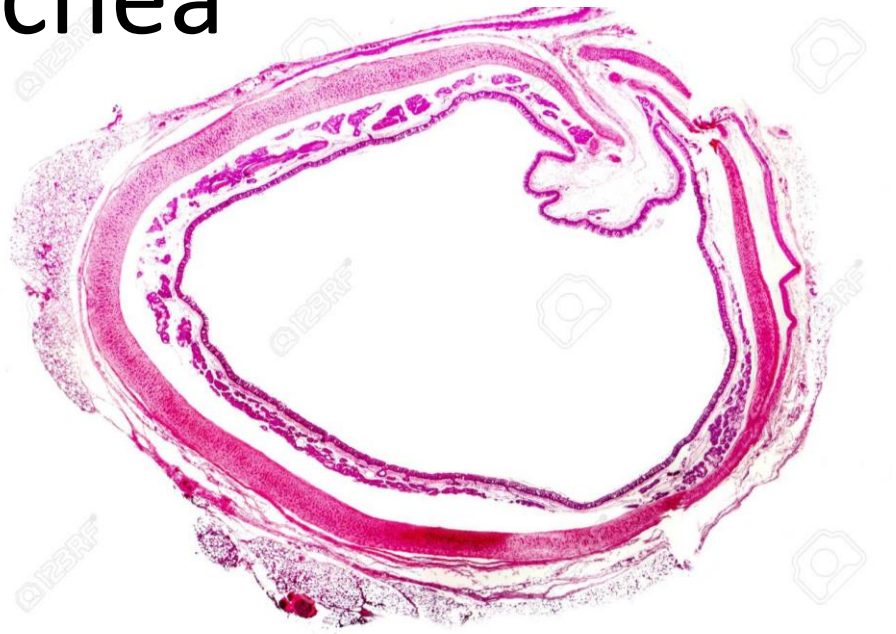


P/S: This is an overly-simplified diagram

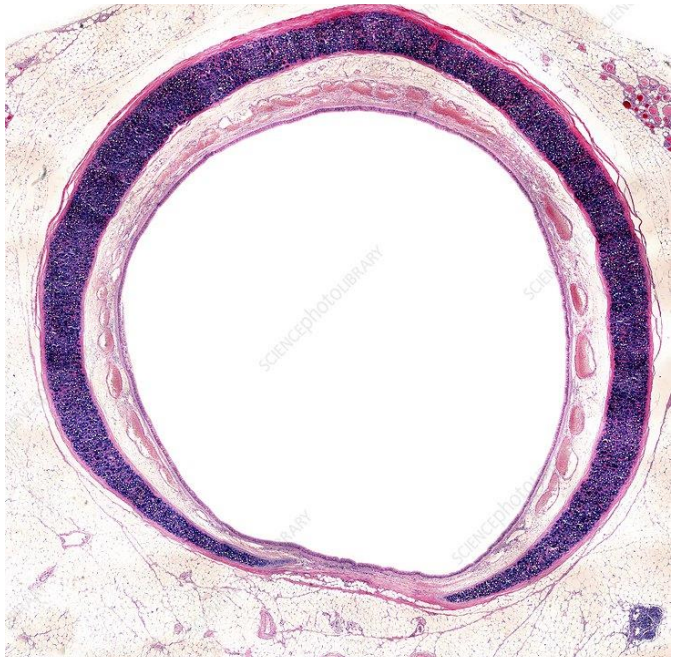
1. Trachea

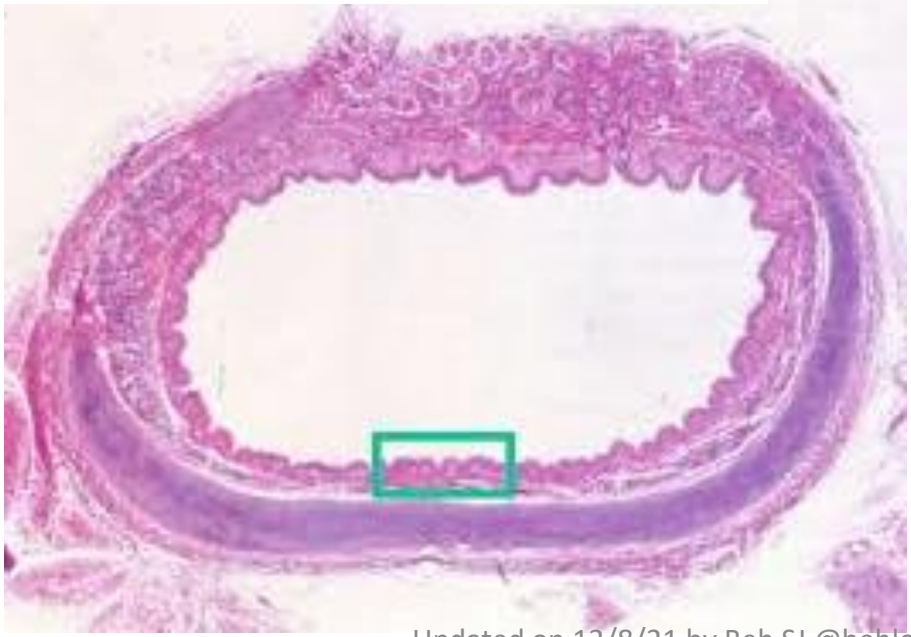

Layers of the tracheal wall.
epithelium
elastic membrane
submucosa
smooth muscle
connective tissue
cartilage
lumen

1. Trachea

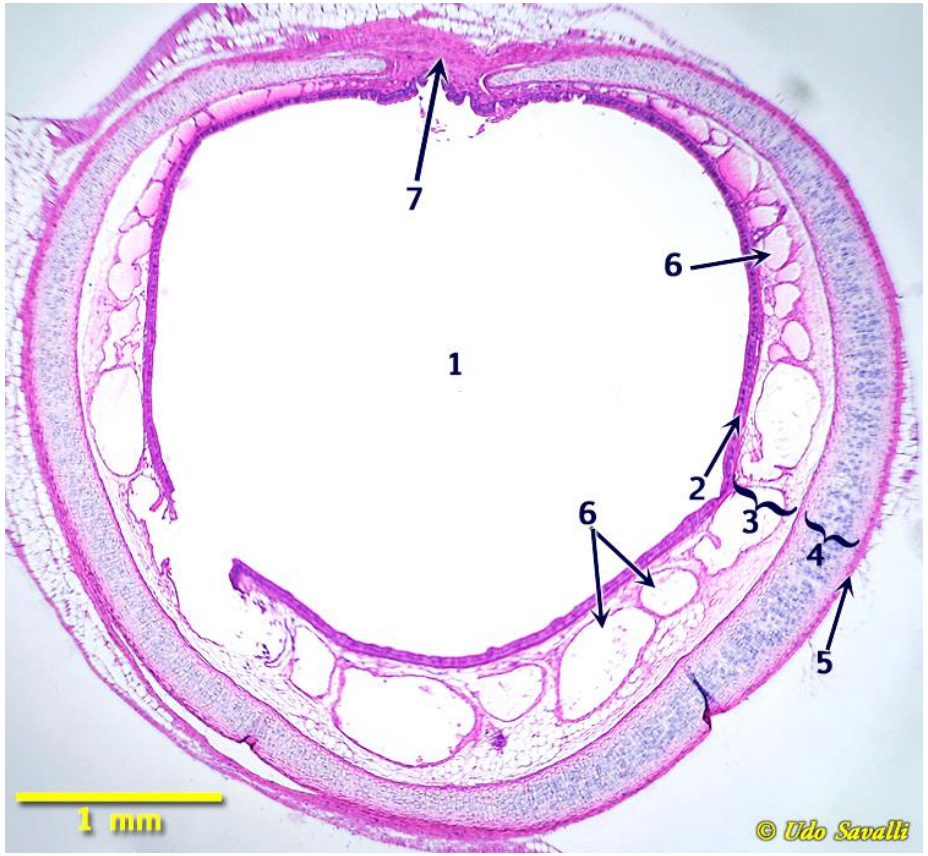


The C-shape cartilage ring is a distinctive feature of the trachea.





1. Trachea



1 lumen

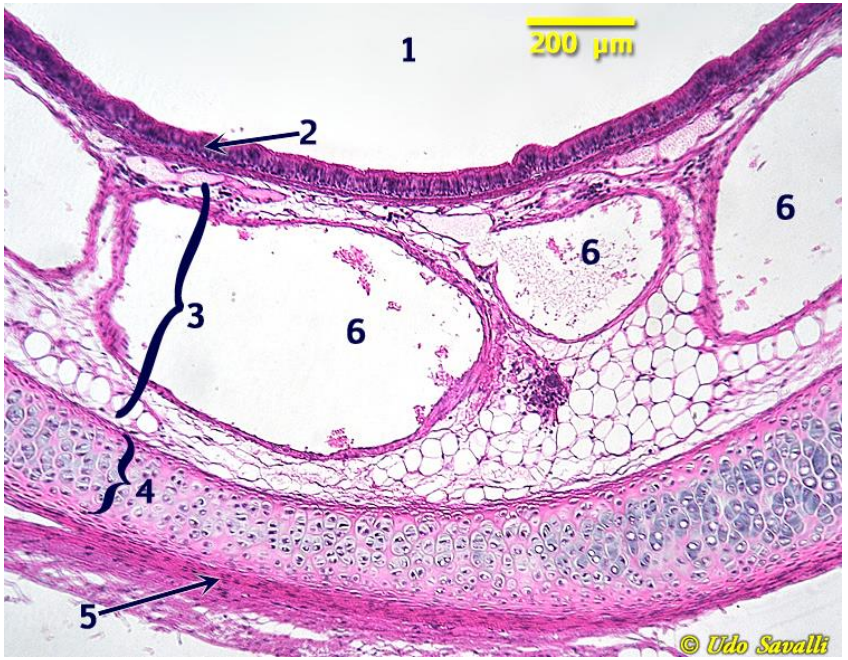
2 ciliated epithelium

3 submucosal layer

4 hyaline cartilage

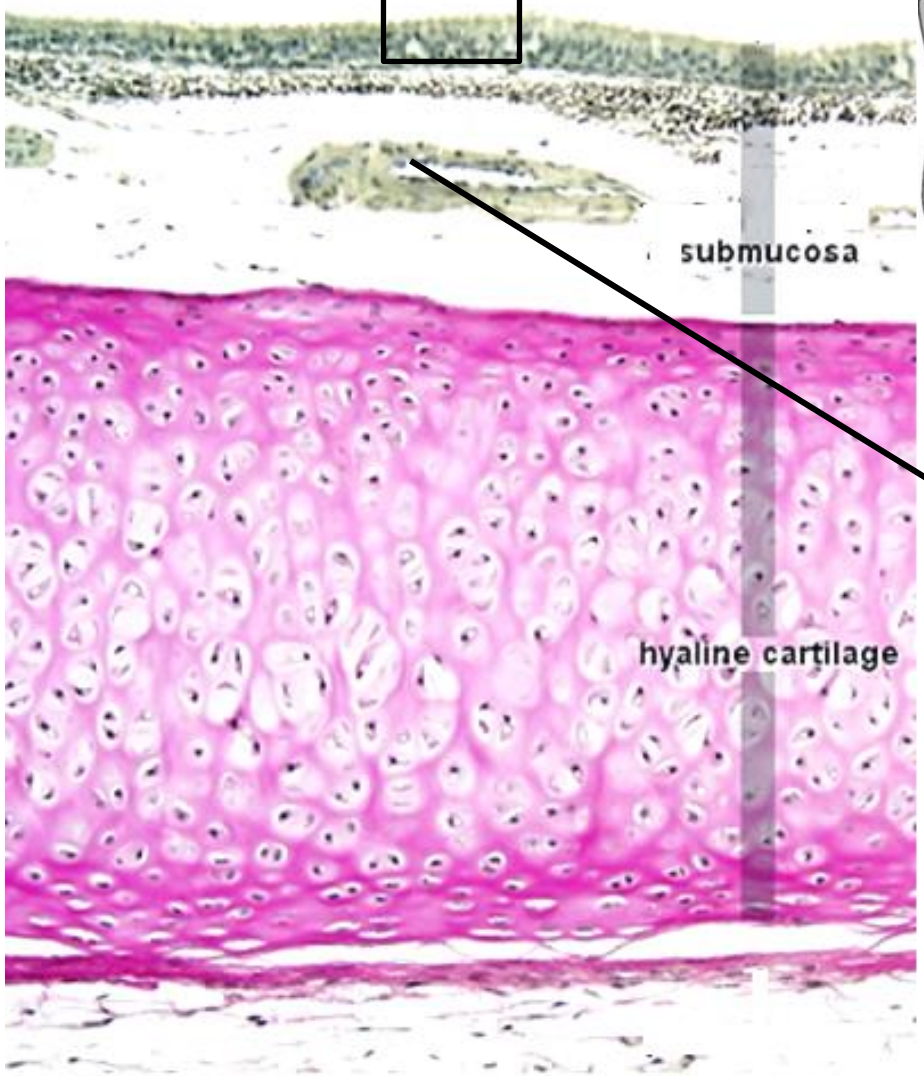
6 mucous glands

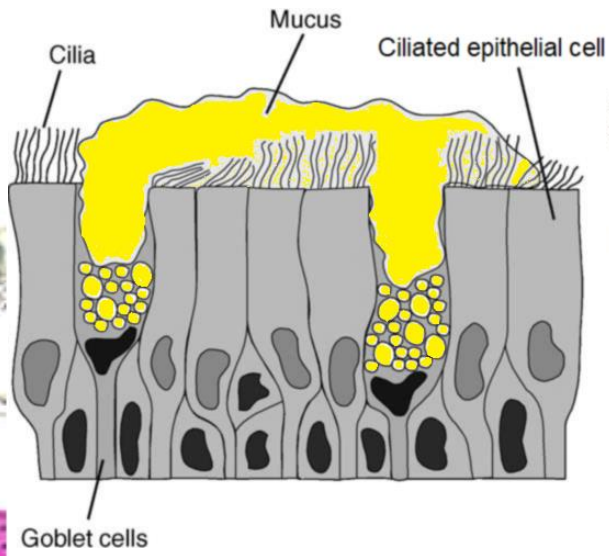
5+7 smooth muscles

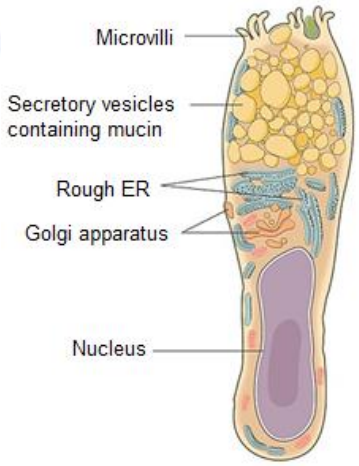


1. Trachea

Ciliated epithelium layer

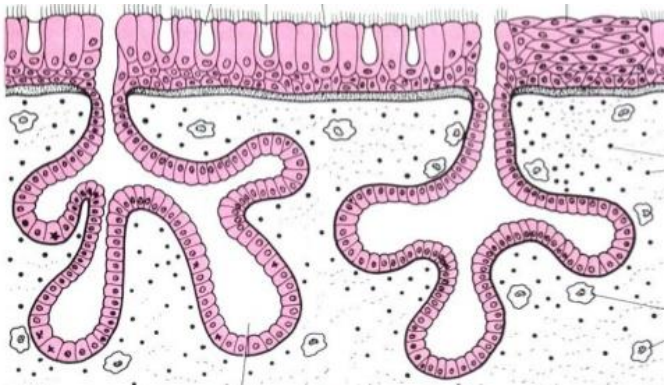




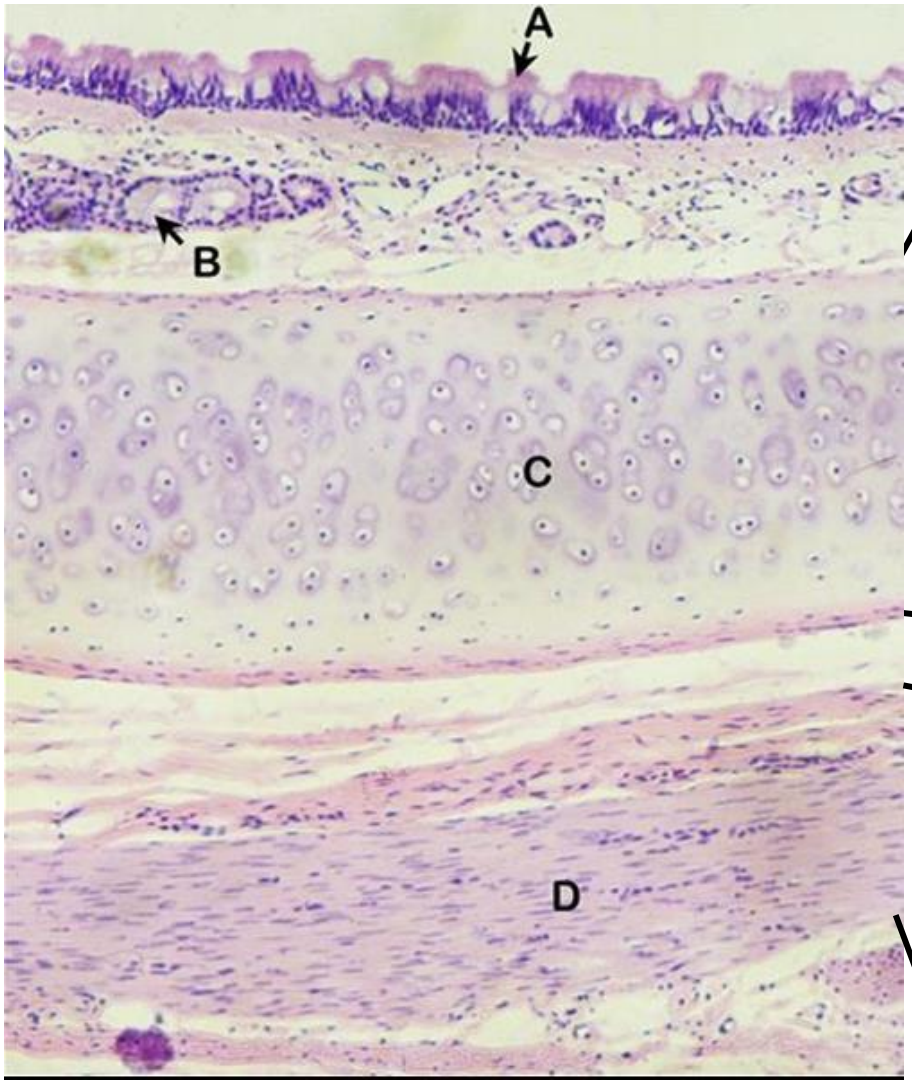


Goblet cell

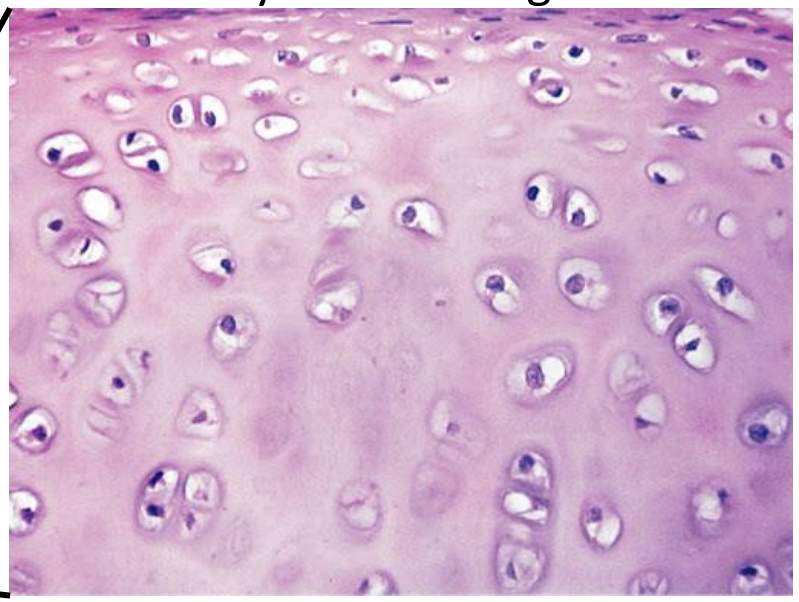
Mucous glands in submucosal layer



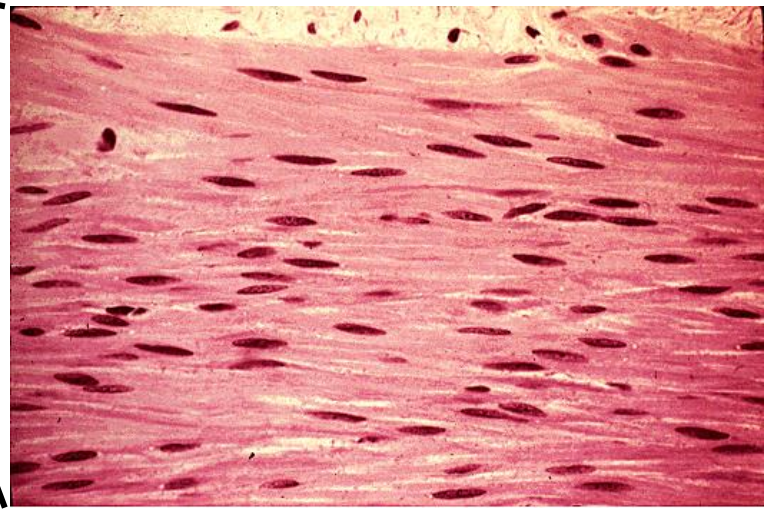
1. Trachea



hyaline cartilage

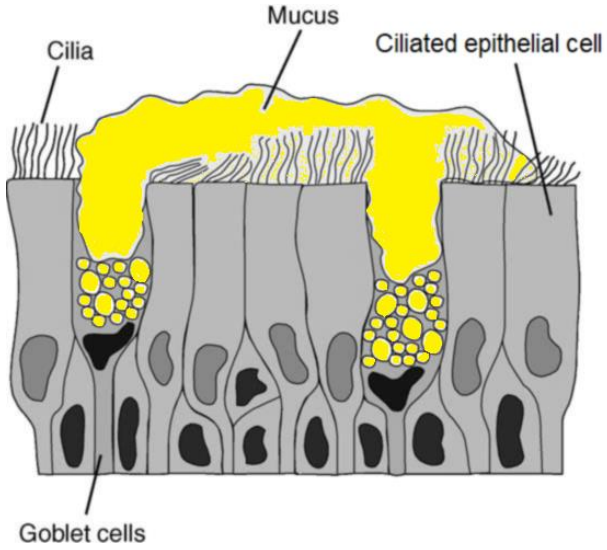


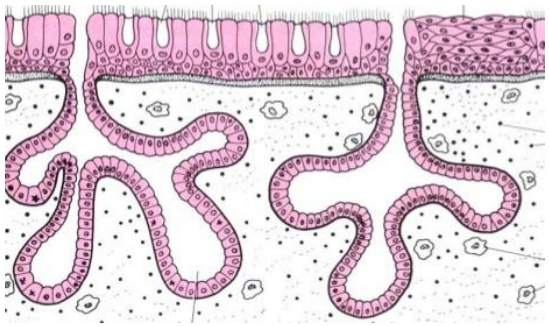
smooth muscle



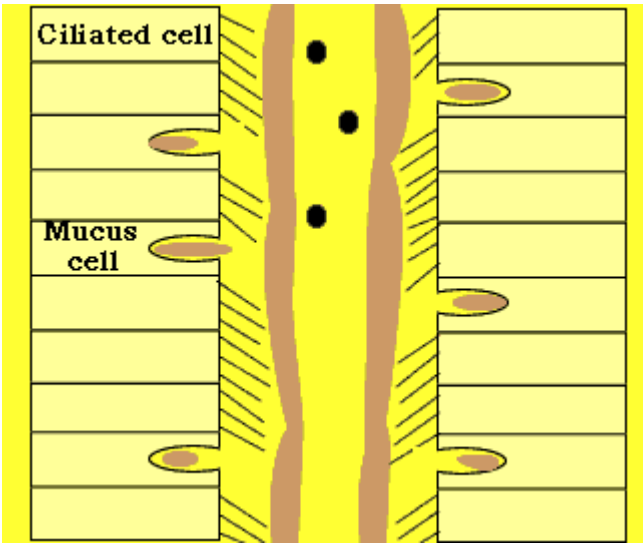
Structures and Functions

Structure	Function
Goblet cells	• Produce **mucus** (made of glycoprotein called mucin) • Mucus traps pathogens, dust etc.
Mucous gland	• Produce **mucus** (made of glycoprotein called mucin) • Mucus traps pathogens, dust etc.
Cilia	• Cilia **move mucus to back of throat** / away from lungs → to be swallowed



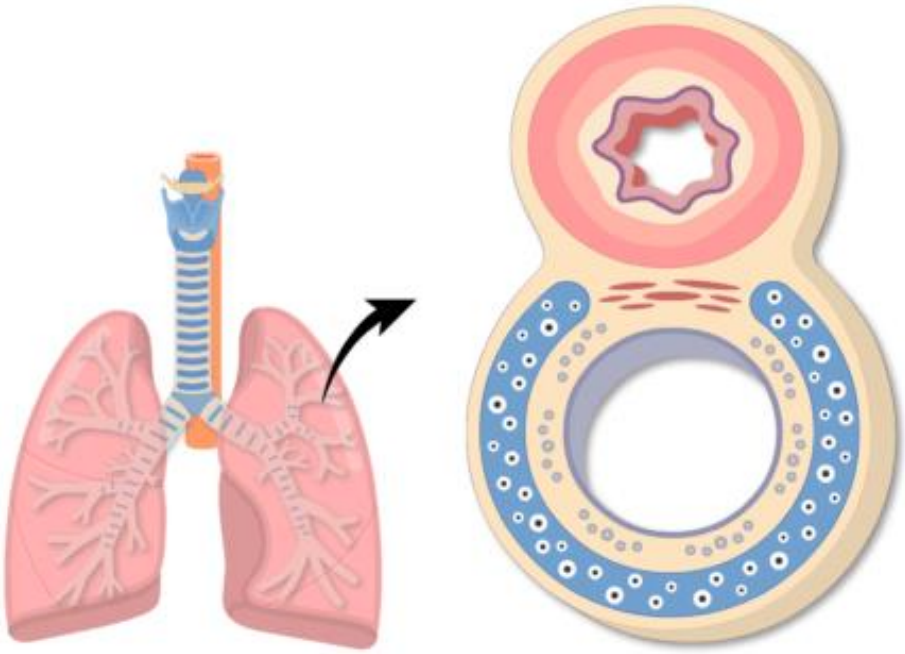


Mucous glands



Structures and Functions

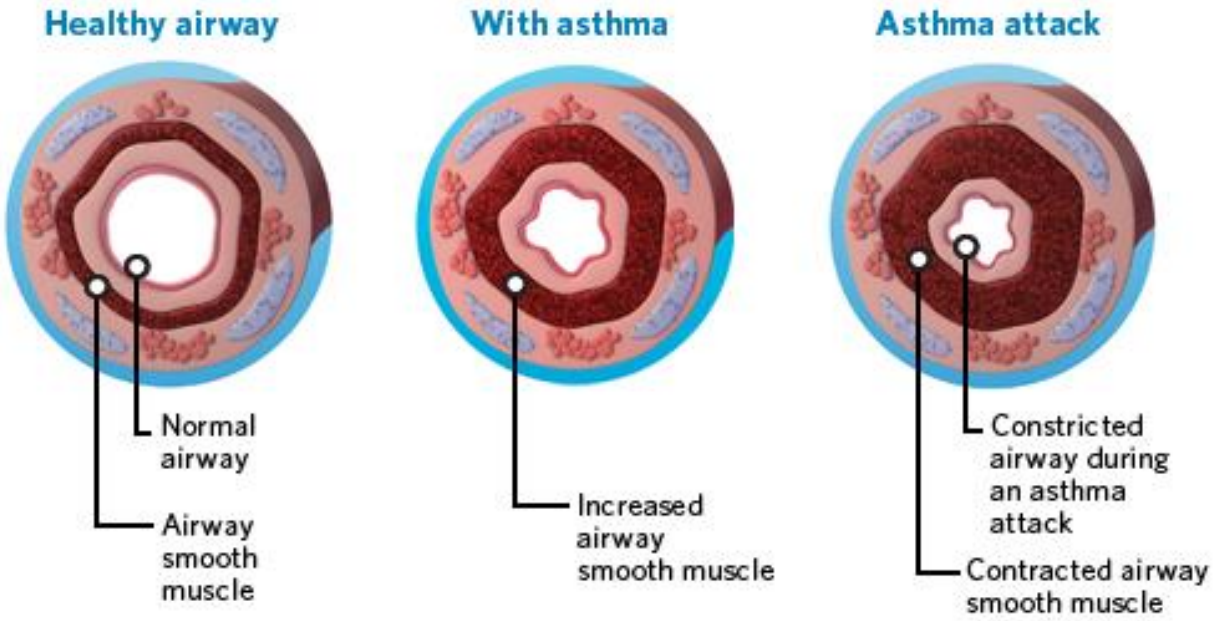
Structure	Function
Cartilage	• **Keeps airway open** → Low air resistance • **Prevents airway from collapsing** during breathing due to changes in air pressure



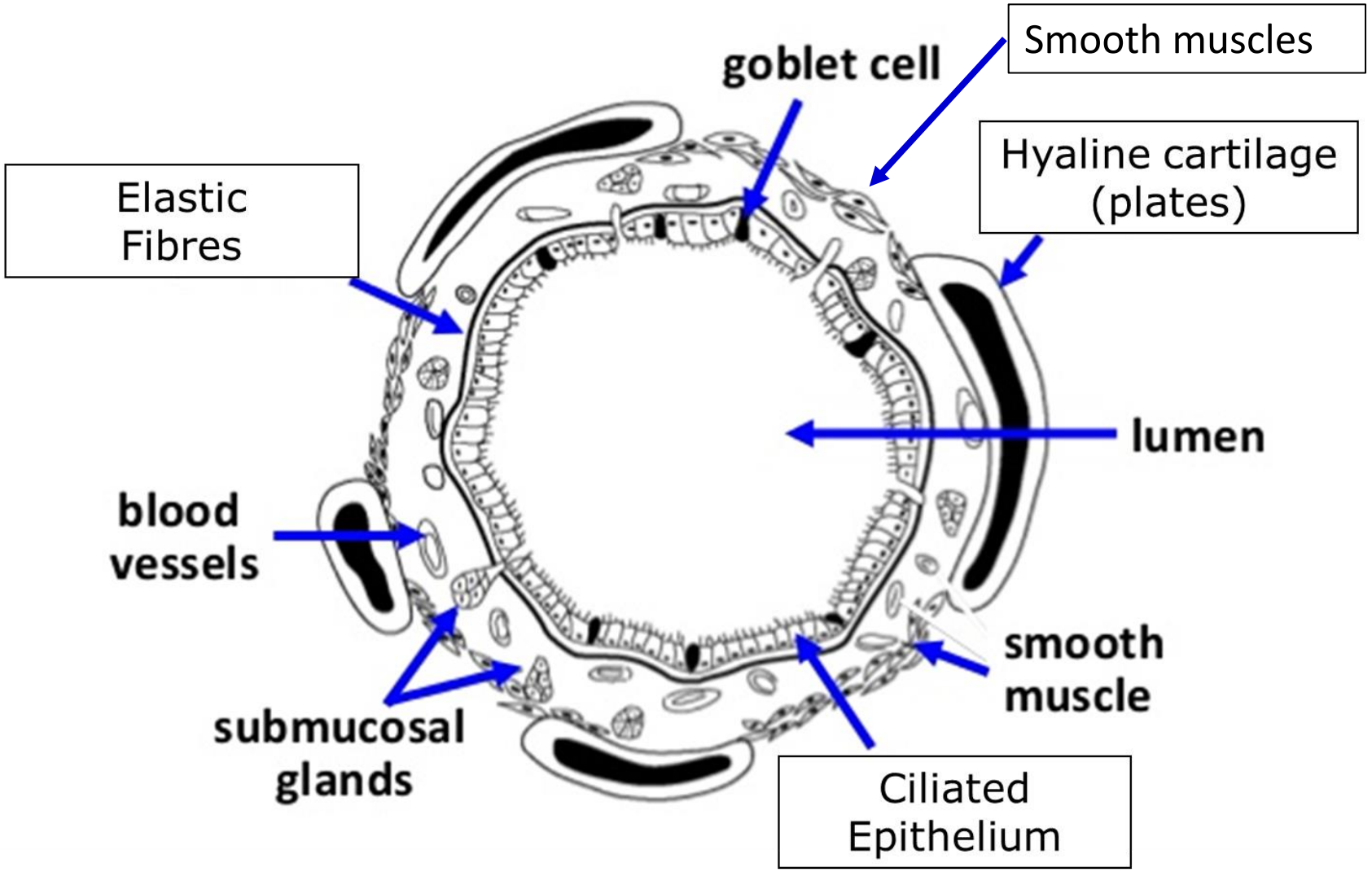
Trachea and esophagus cross section

Structures and Functions

Structure	Function
Elastic fibres	• Can **stretch** during inspiration, **recoil** during expiration • When elastic fibres stretch: increase surface area • When elastic fibres recoil: expel air
Smooth muscle	• When it **relaxes**: the airway widens (e.g. during exercise) • When it **contracts**: the airway constricts

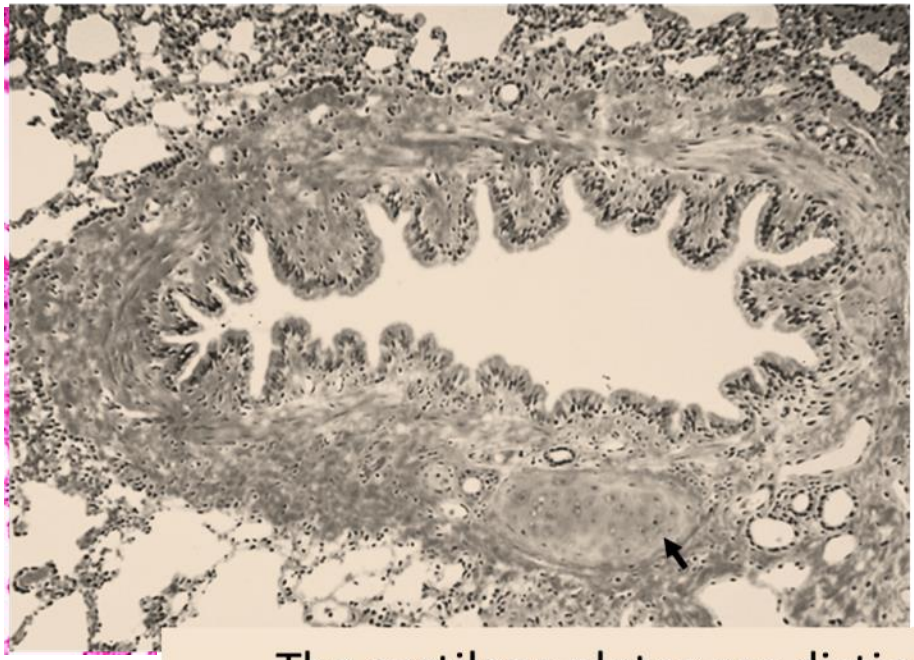


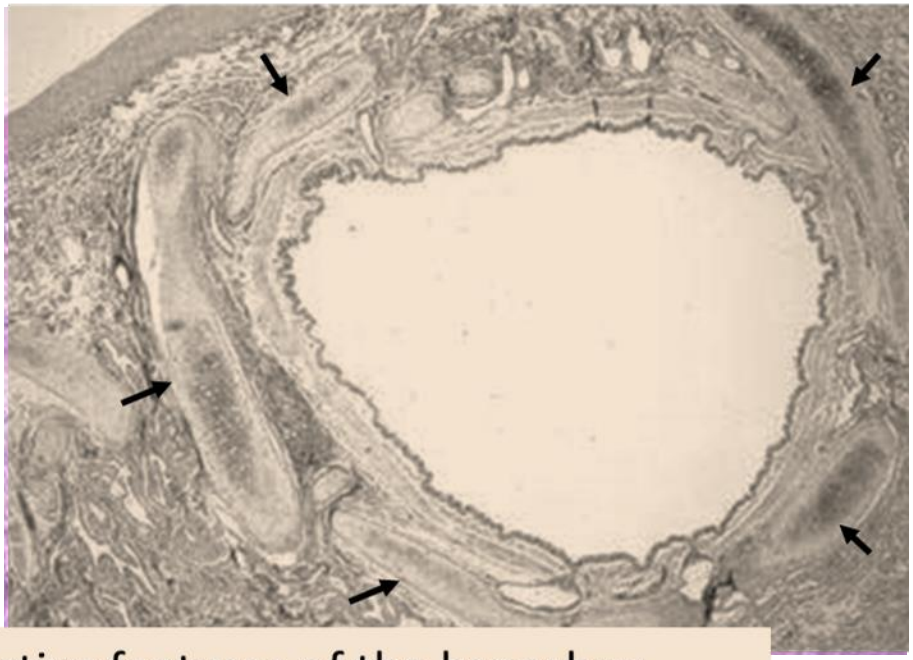
2. Bronchus



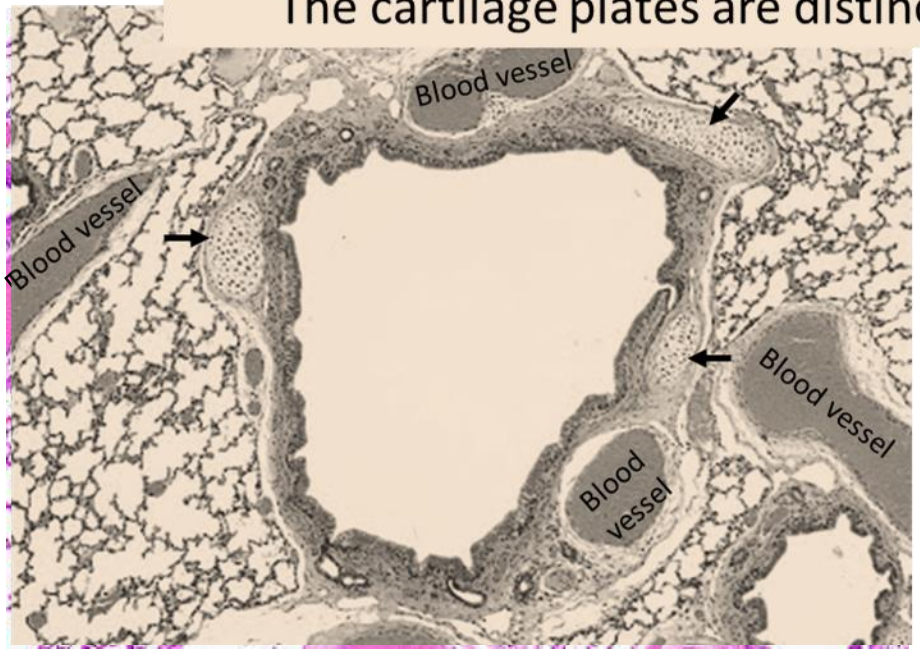
P/S: This is an overly-simplified diagram

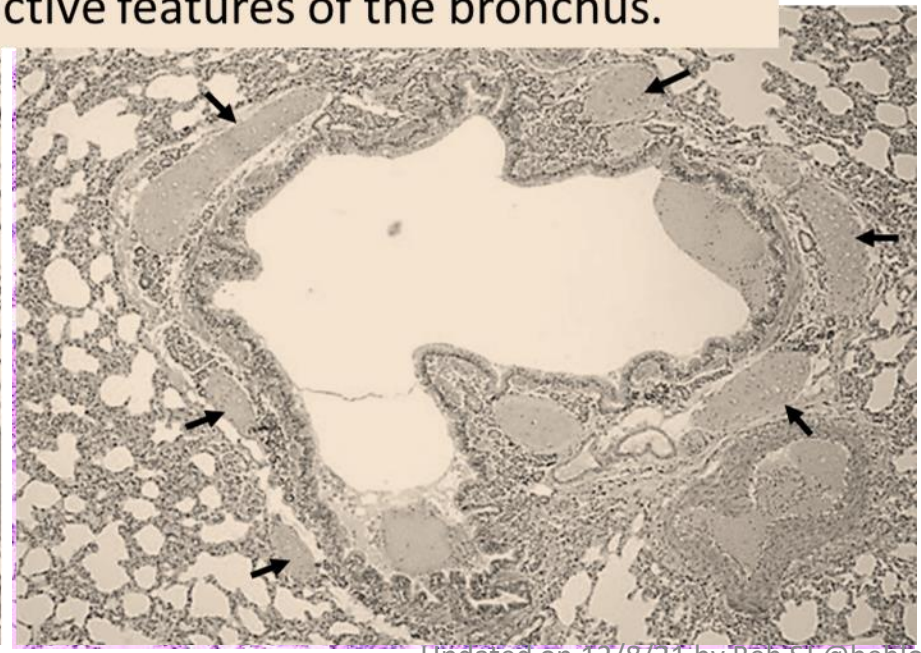
2. Bronchus



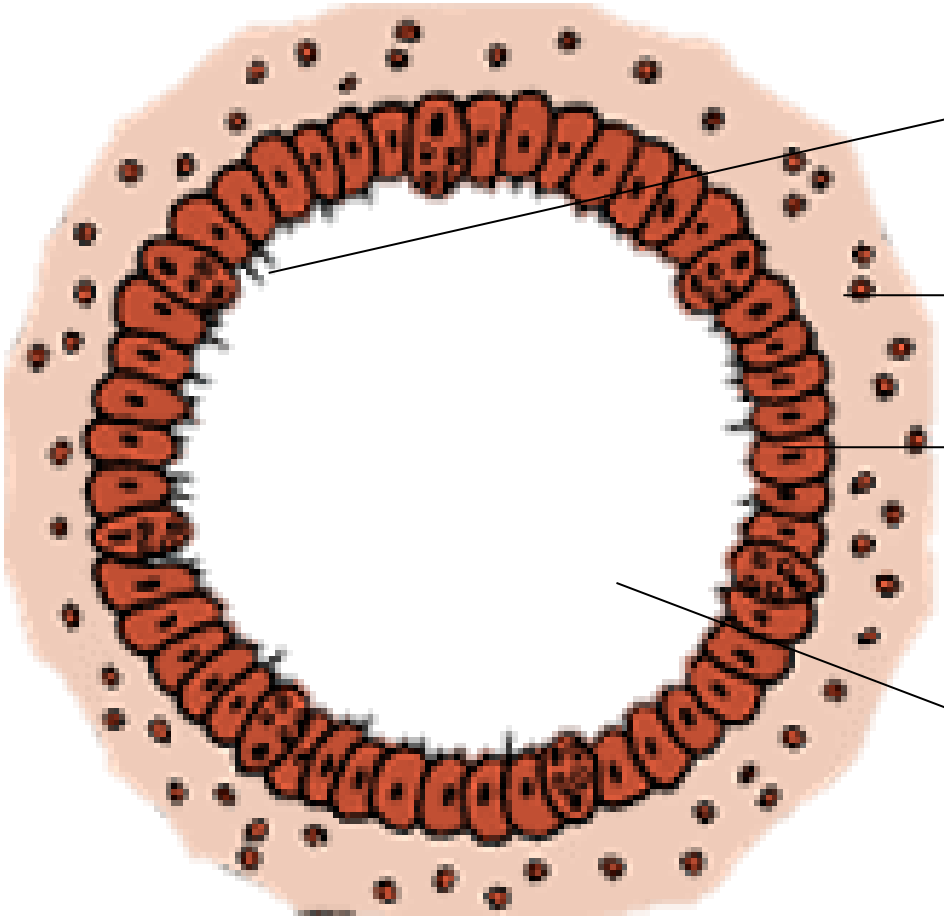


The cartilage plates are distinctive features of the bronchus.





3. Bronchiole



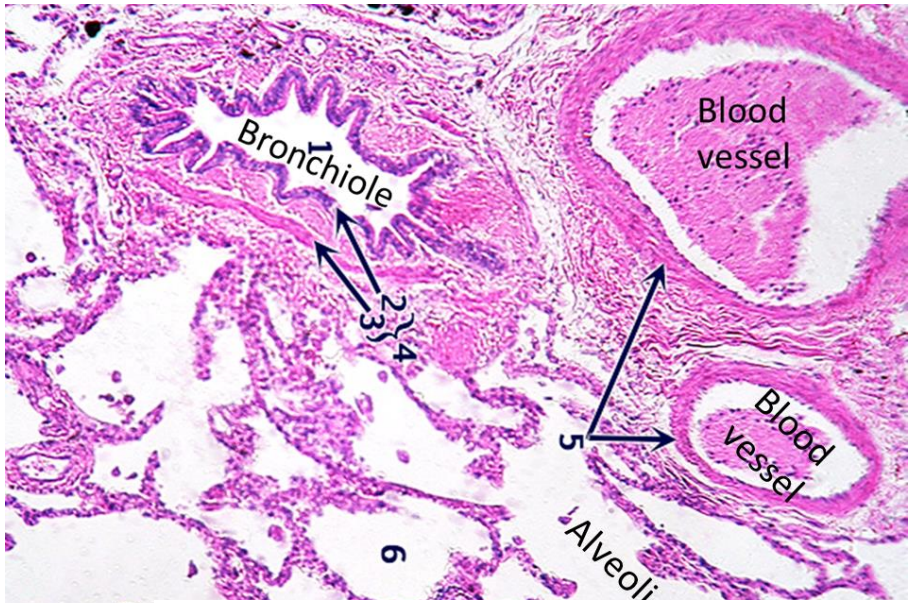
P/S: This is an overly-simplified diagram

Terminal bronchioles (nearer to bronchus) have some smooth muscle

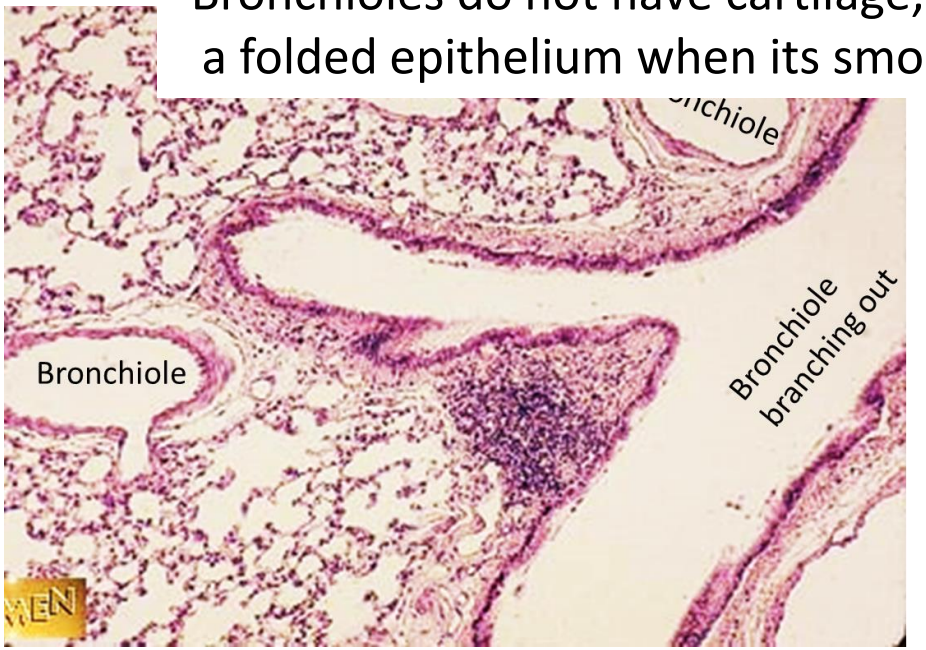
Respiratory bronchioles (further from bronchus) do not have smooth muscle and have less cilia

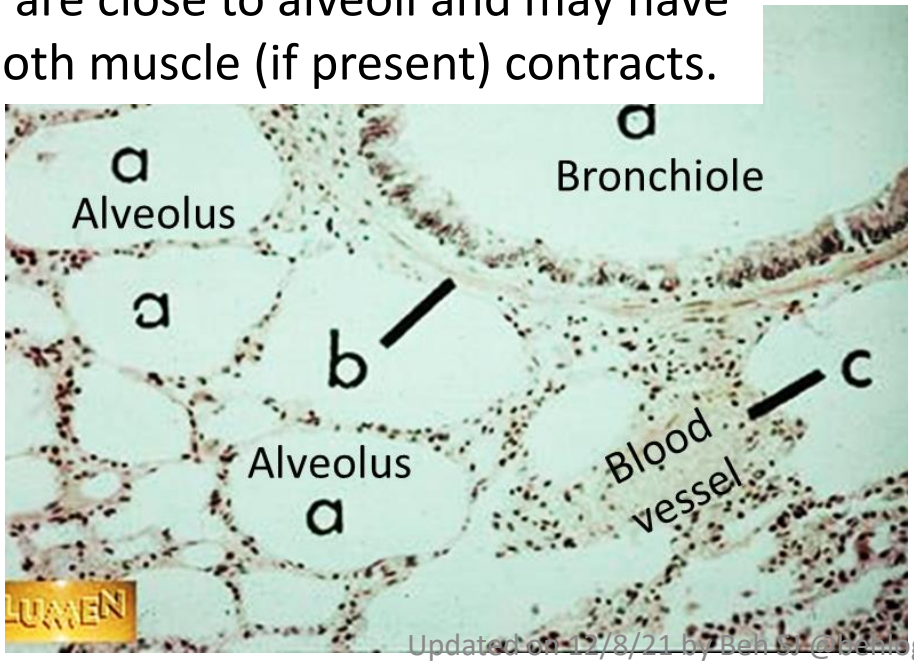
Updated on 12/8/21 by Beh SJ @behlogy

3. Bronchiole



Bronchioles do not have cartilage, are close to alveoli and may have a folded epithelium when its smooth muscle (if present) contracts.





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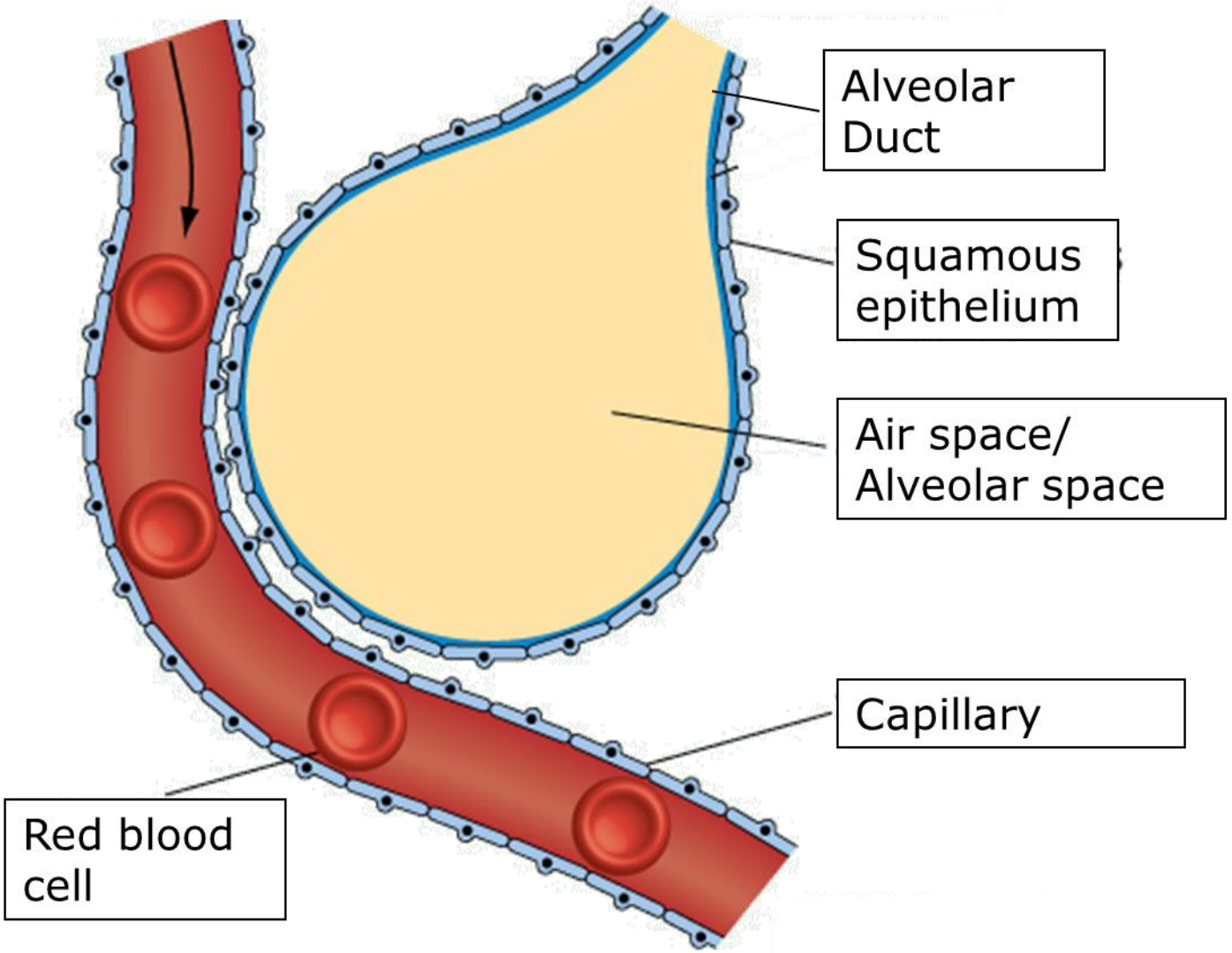
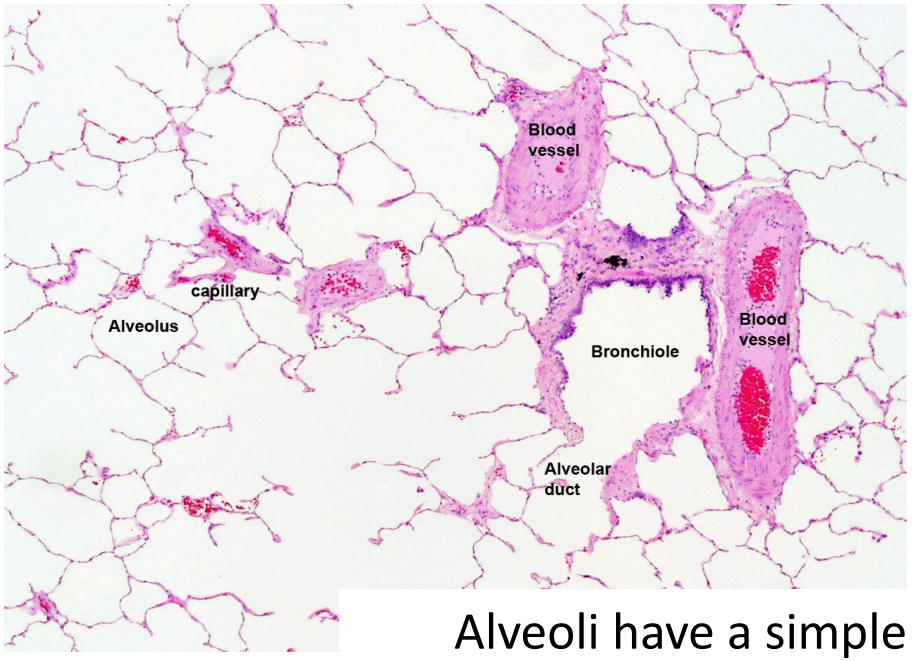
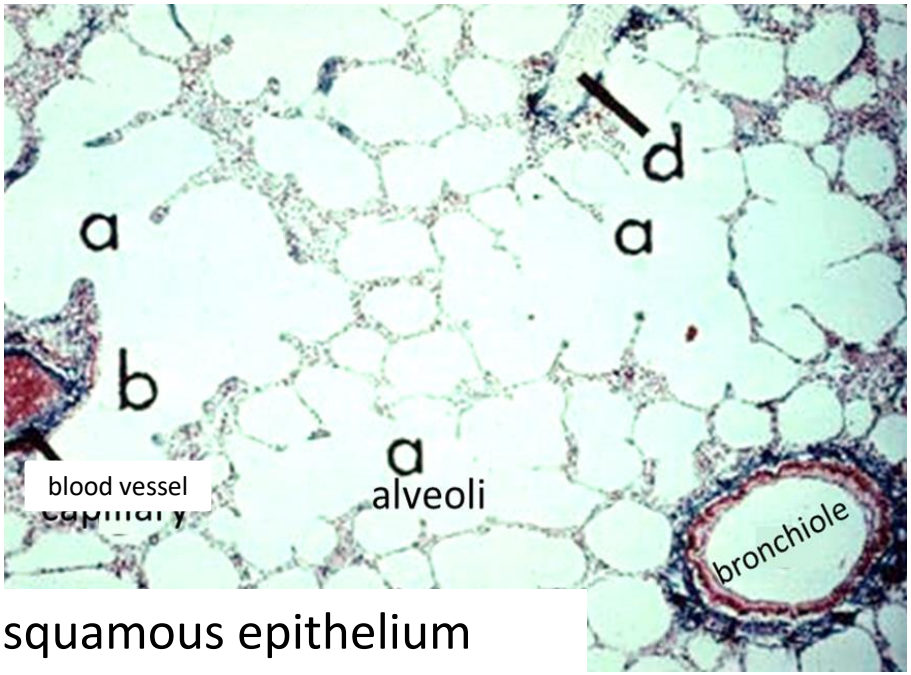
4. Alveolus

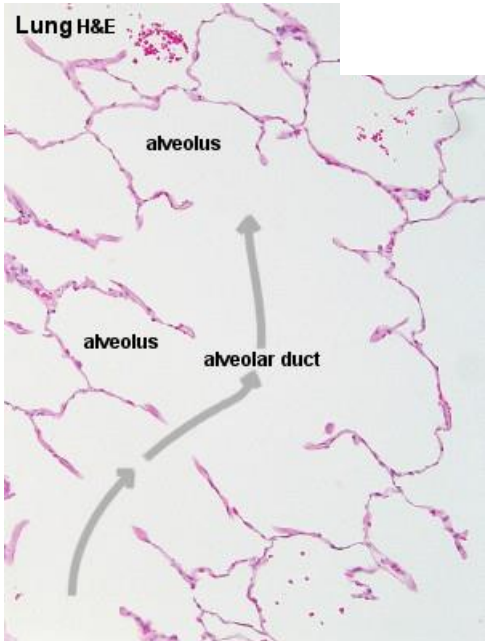

Alveolar Duct
Squamous epithelium
Air space/ Alveolar space
Capillary
Red blood cell

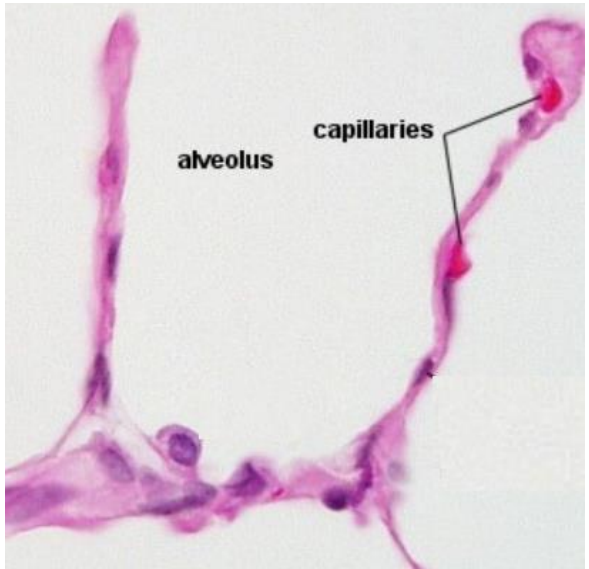
4. Alveolus

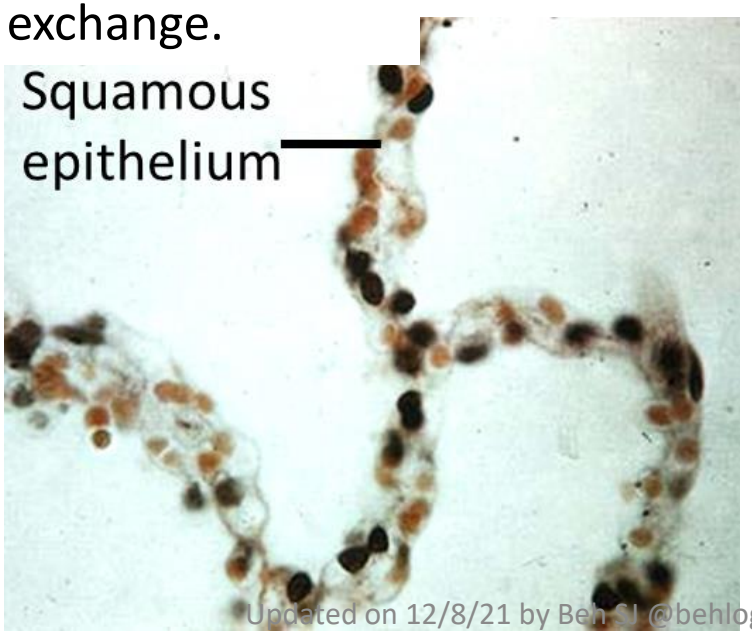




Alveoli have a simple squamous epithelium and is the site of gaseous exchange.







4. Alveoli

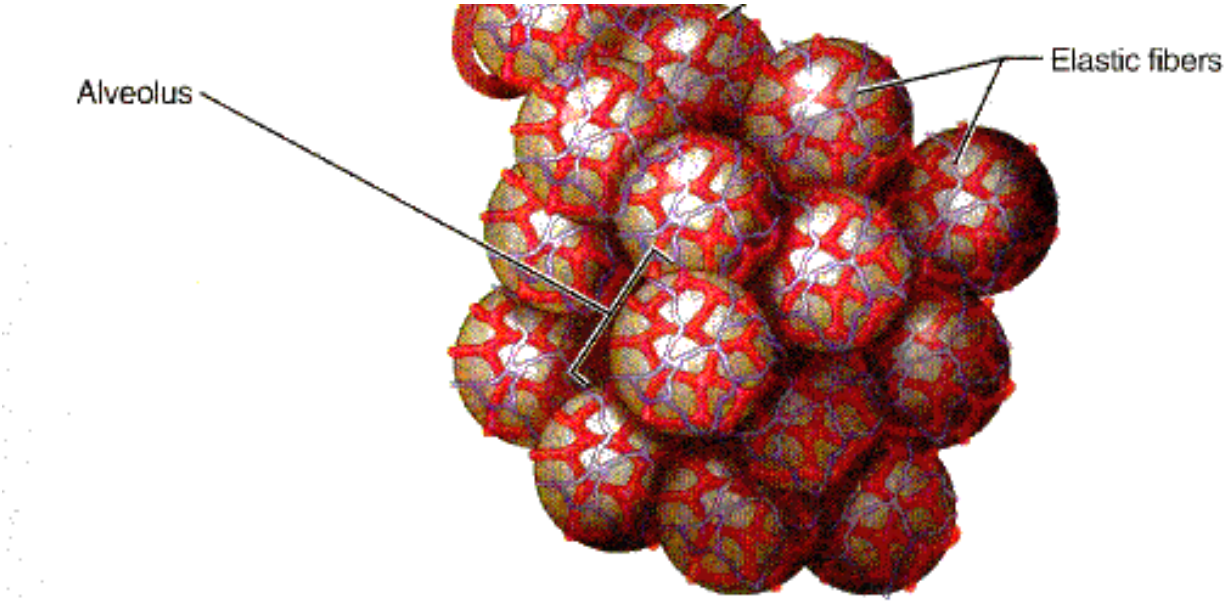
Features to enable rapid diffusion of gases:

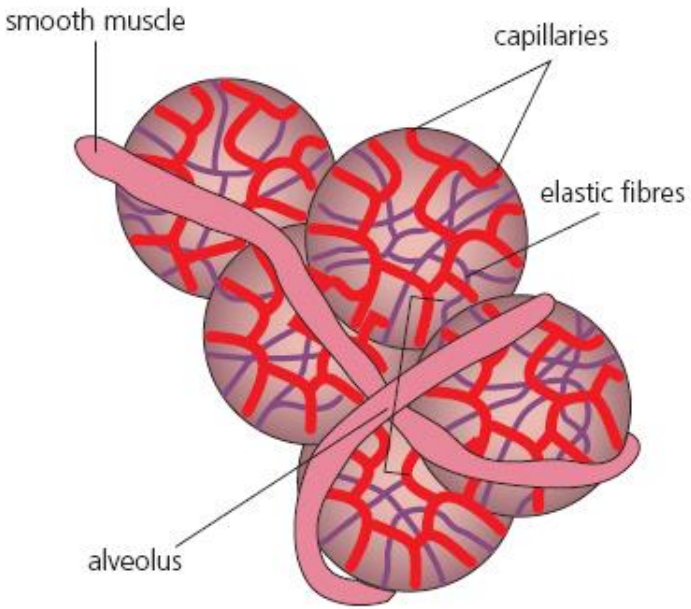
1) **One-cell thick**

- Squamous epithelial cells

→ **Short diffusion distance** between air & blood

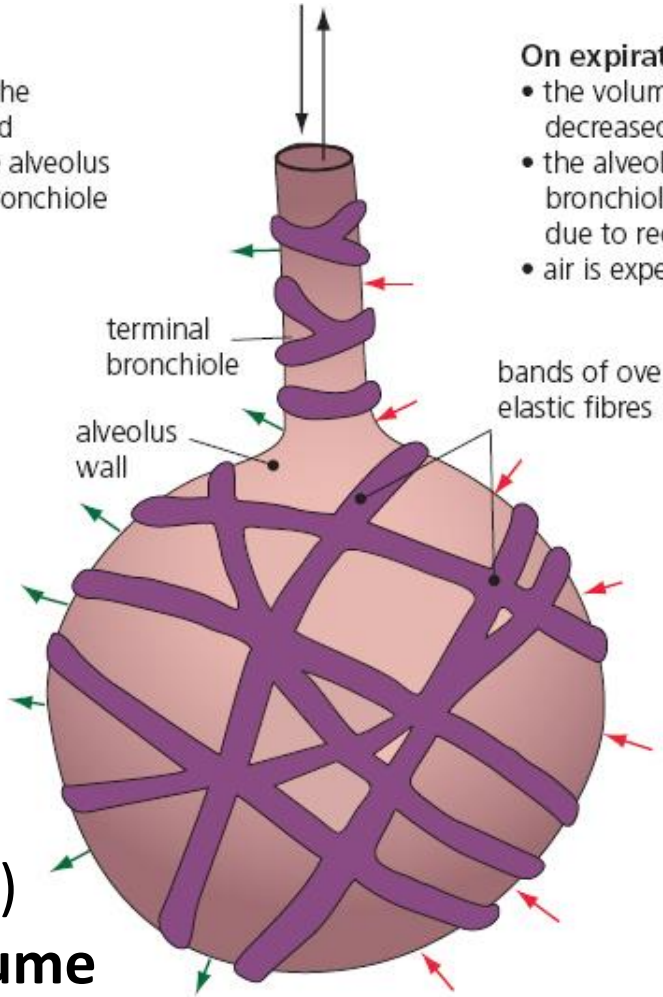
2) Collectively **large surface area** for diffusion





On inspiration
- the volume of the thorax increased
- the walls of the alveolus and terminal bronchiole are stretched
- air is drawn in

On expiration
- the volume of the thorax decreased
- the alveolus and terminal bronchiole revert to resting size, due to recoil of the elastic fibres
- air is expelled

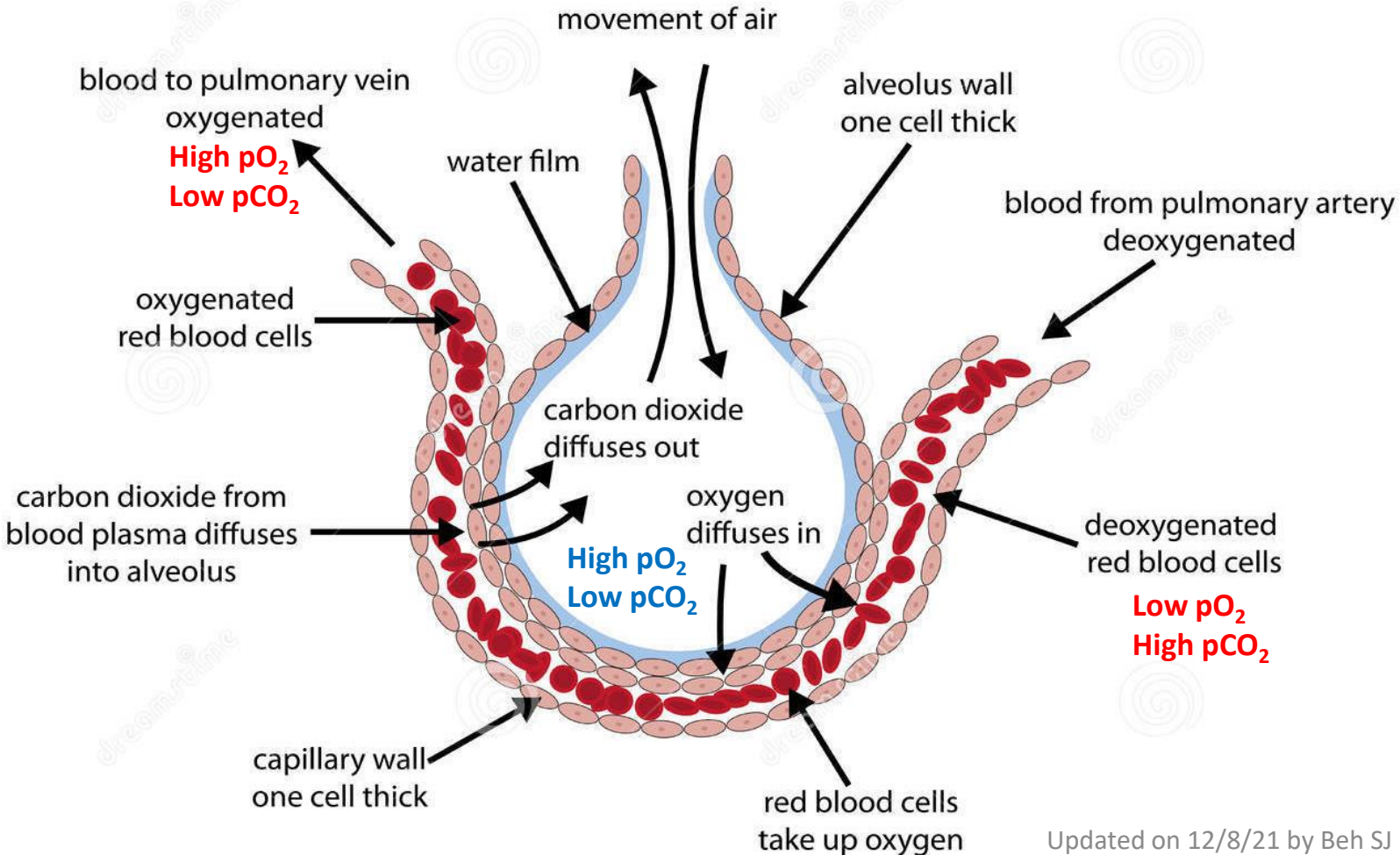


3) Walls have **elastic fibres** (elastin)

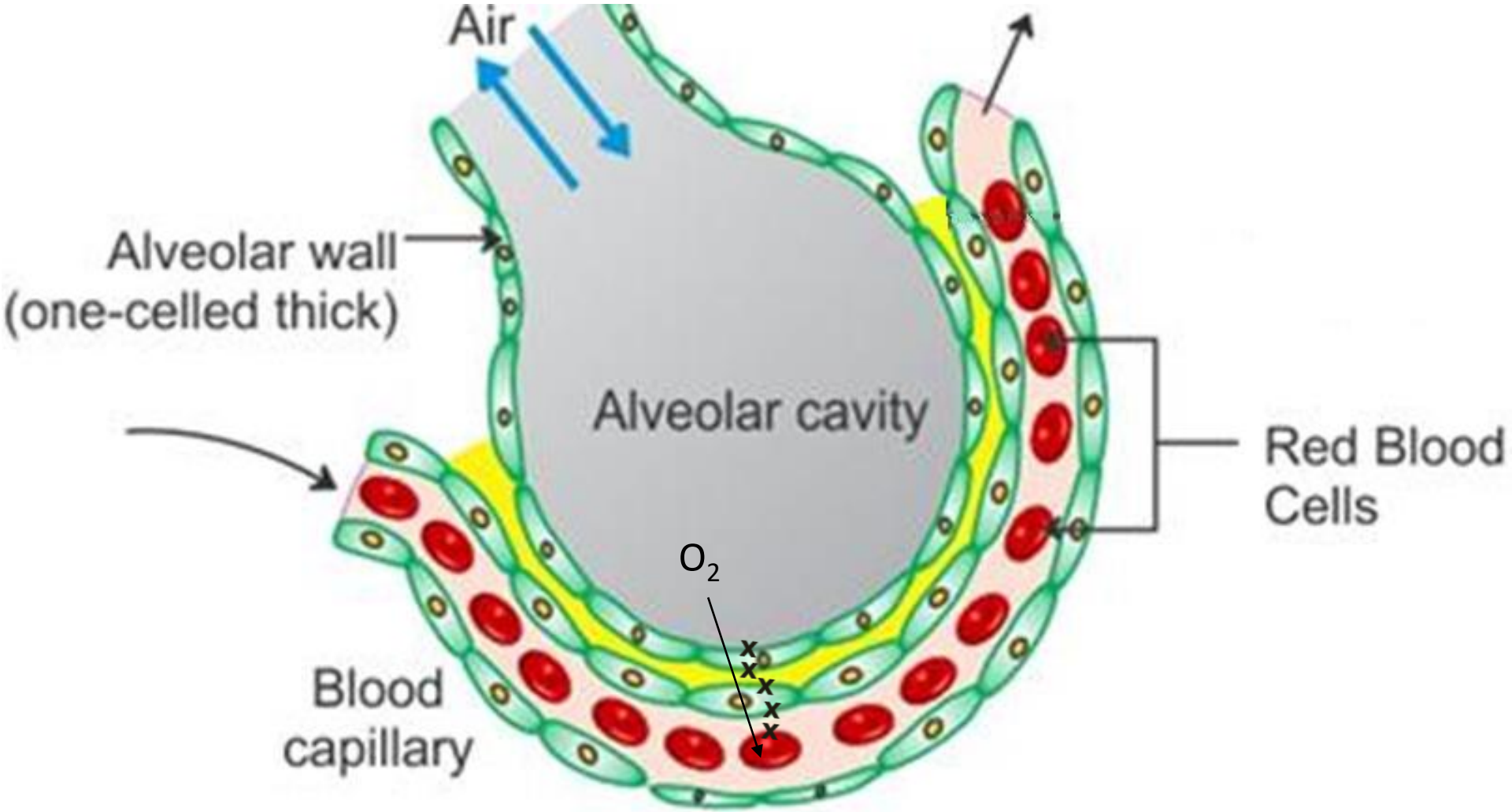
- **Allow alveoli to increase in volume**
- When elastic fibres stretch: increase surface area
- When elastic fibres recoil: expel air
- Prevent bursting

4) Surrounded by **network of capillaries**

- **Maintain a steep diffusion gradient**
- Blood is also slowed in the capillaries
- **Good ventilation of the lungs** and **good circulation of blood** maintains the necessary concentration gradients for carbon dioxide and oxygen

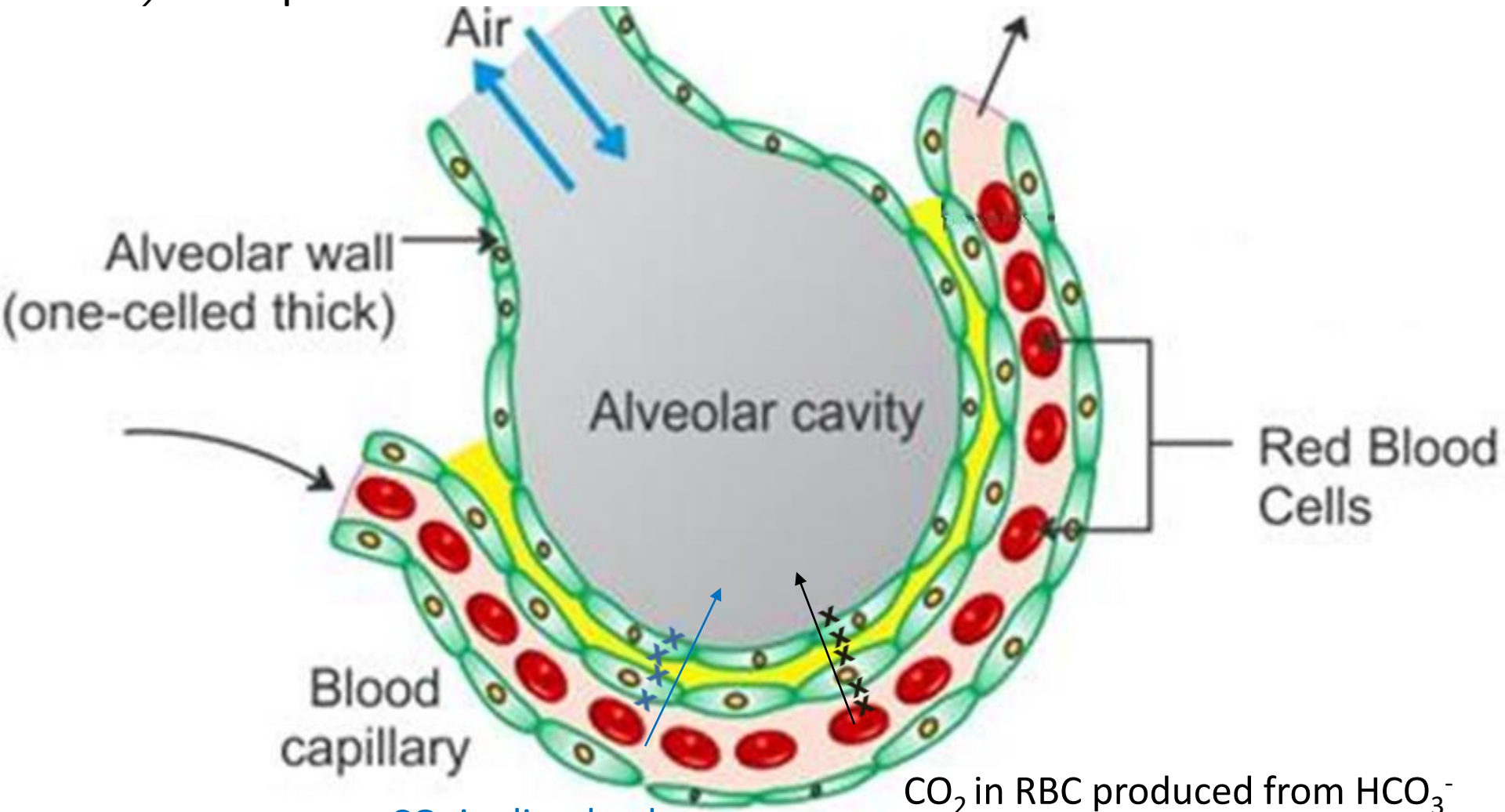


What is the number of cell surface membranes through which oxygen must pass?



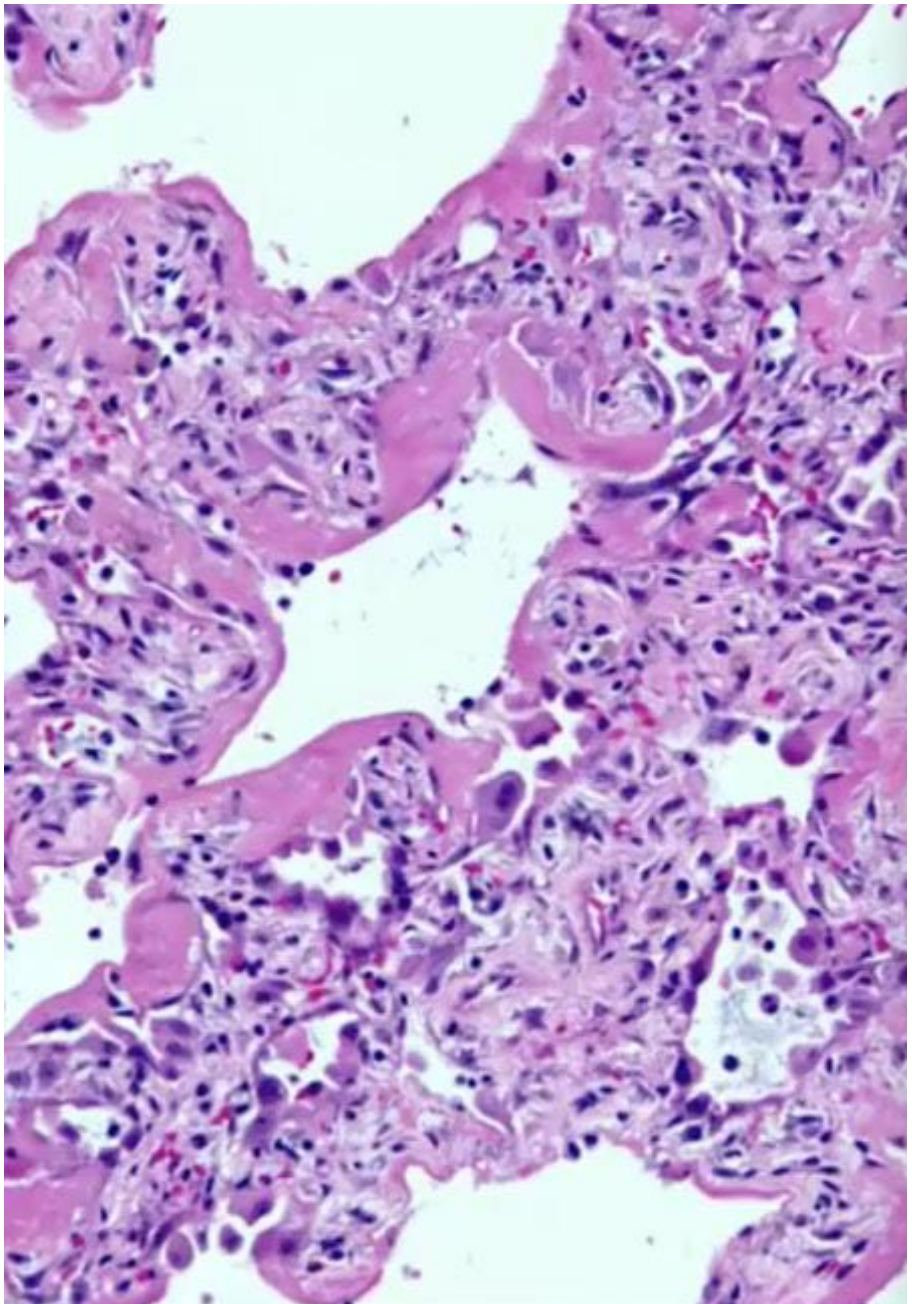
Answer: 5

What is the number of cell surface membranes through which CO_2 must pass?

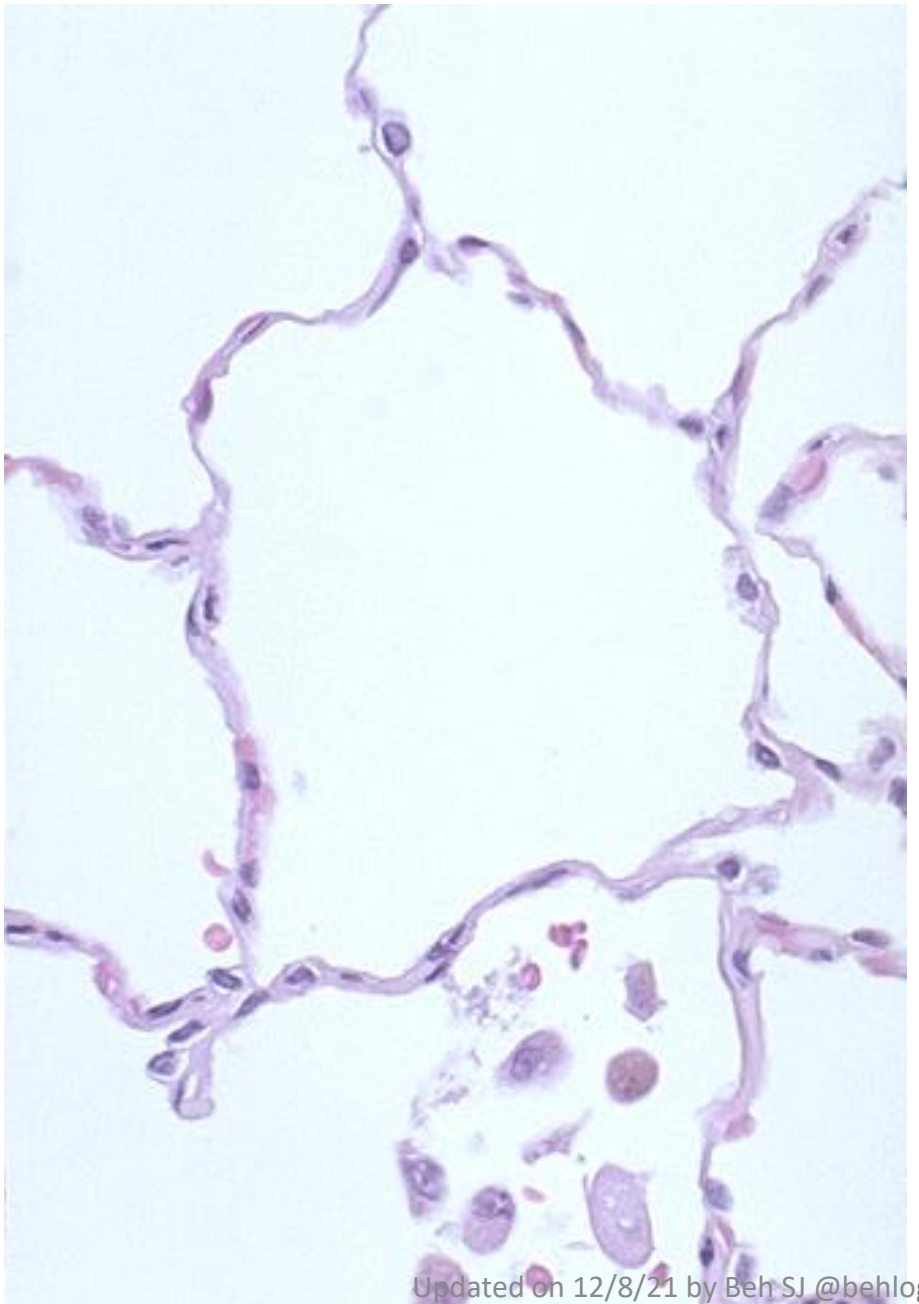


Answer: 4 or 5

Acute Respiratory Distress Syndrome (ARDS)
COVID-19



Normal



Updated on 12/8/21 by Beh SJ @behlogy

Summary

	Ciliated epithelium	Hyaline cartilage	Smooth muscle	Site of gas exchange
Trachea	✓	✓	✓	×
Bronchus	✓	✓	✓	×
Bronchiole	✓	×	×	×
Alveolus	×	×	×	✓

Structure	Function
Goblet cells + Mucous gland	• Produce **mucus** (made of glycoprotein called mucin) • Mucus traps pathogens, dust etc.
Cilia	• Cilia **move mucus to back of throat**
Cartilage	• **Prevents airway from collapsing**
Elastic fibres	• Can **stretch** during inspiration, **recoil** during expiration
Smooth muscle	• When it **relaxes**: the airway widens When it **contracts**: the airway constricts